

Potentials of Wind Power in Hungary

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Summary

Among renewable resources wind energy was the first in Hungary that initiated intense discussion and brought the mistakes and insufficiency of Hungarian regulation and strategic planning to the surface. In this article we examined the possibilities that wind energy offers for Hungary, also we compared our current situation and possible ways of development to international trends. The examination covered the effects of the above mentioned planning problems on Hungarian wind energy sector. Instead of focusing on solely scientific aspects our main motivation was to draw attention, give information and deepen the knowledge of decision makers and energy experts. The special toolkit of geography can open new perspectives for Hungarian regional development and energy planning.

Keywords: renewable energy sources, wind power potentials,

1. Introduction

Wind energy is attracting growing attention as a sustainable and renewable energy source, which is one of the fastest growing sector in energy production. However, there are diverging estimates on potentials of this energy. There are two facts in its background: at first there are different types of potentials when evaluating energy purposes, at second the development of the wind energy technology is very fast therefore the output of wind turbines are growing apace.

In this paper we summarize the different conceptions about wind energy potentials of Hungary. Our method was manifold. We made GIS applications in two sample areas. In addition we analyzed the earlier published studies and moreover the governmental strategies in this field and compared them the results of our research. It is important to remark that this research topic is a serious challenge since it requires a many-sided approach (land use planning, ornithology, wind turbine technology), an interdisciplinary line. We hope that the results of this work will be used in the practice of making energy strategy and therefore these will contribute to a sustainable energy management.

2. Types of energy potentials

In this paper we examine the potential of wind power in Hungary. It is not as easy topic as it seems, namely there are several types of potentials. And what is more, unfortunately in this question we do not have a firmly established scientific agreement. Actually there are different approaches even in the field of different renewable energy sources. After all there are four general types:

- a) The theoretical potential calculates energy available from all surfaces (land and water).
- b) The technical potential looks at that how large a fraction of this land could be made available to wind power (from legal and technological point of views) and it calculates with this basic information.
- c) The socio-economic potential addresses the profitability and the acceptance of wind energy systems.
- d) The implementation or program potential reviews constraining and enabling factors for wind power production within a timeframe and scale. It is important to recognise that the implementation potential can be higher (rather than lower) than the economic potential because it can be influenced by supportive policies and measures.

3. Theoretical wind energy potential in Hungary

According to the international apportionment there are 7 different classes of wind climate. Almost all of the territory of Hungary is ranked among Class 1, as its average wind speed is moderate (figure 1.).

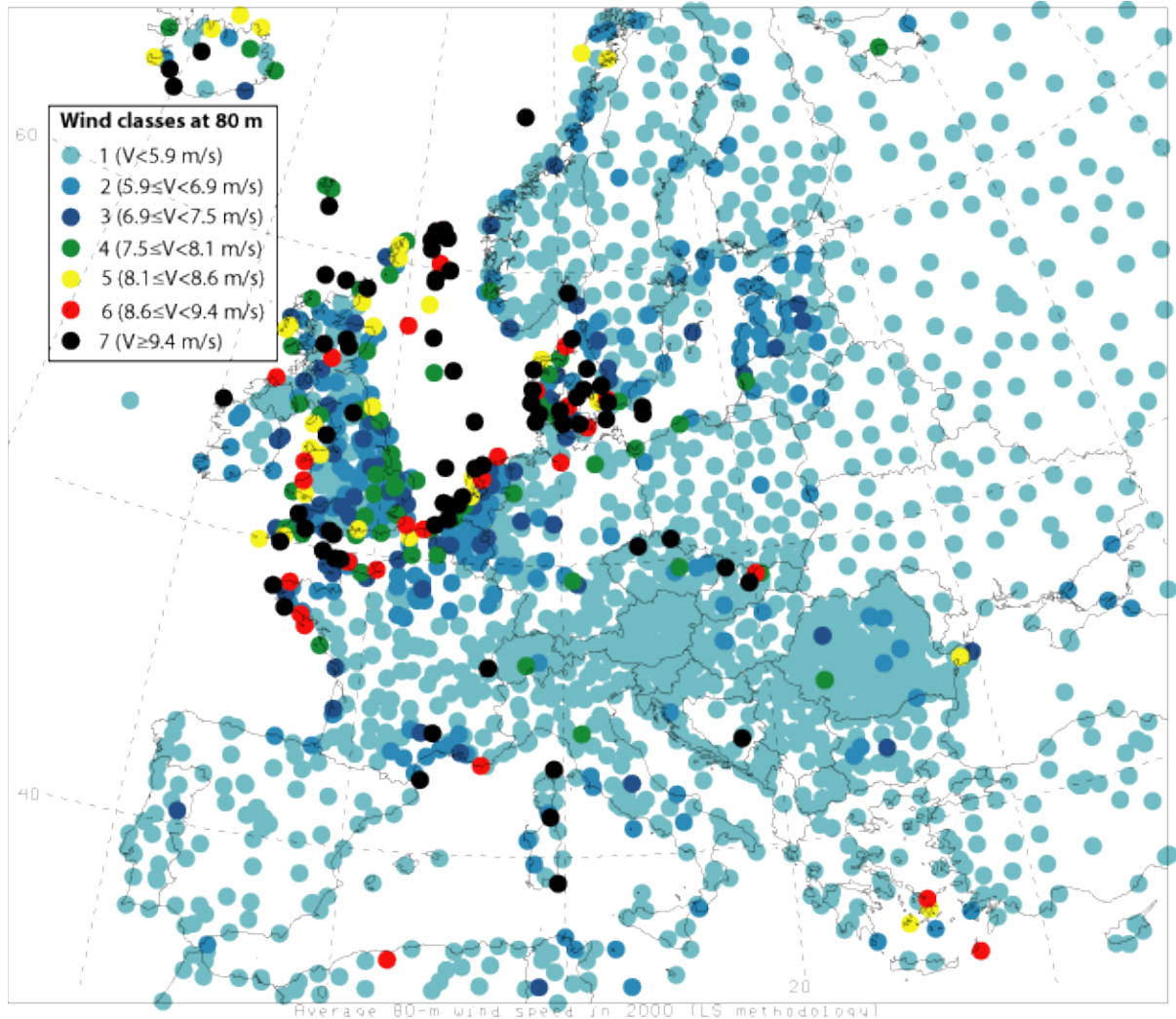


Figure 1: Wind speed in Europe in the height of 80 metre. Source: Archer, C. L. – Jacobson, M. Z. 2005

It is a normal phenomena as Hungary is situated in the middle of the continent, in very big distance from the windy seashores. As the figure indicates Hungary has a more or less homogenous wind potential, but the map indicates some more favourable areas as well. These regions can be the grounds of wind energy applications.

But this kind of representation can give just a general view of the possibilities. The more detailed analyses show a more subtle picture, where the North-Western part seems to be the most suitable area of the country for wind energy projects (figure 2.). This concept is supported by the in situ wind measures and also the practice as the majority of wind turbines work in these counties of Hungary.

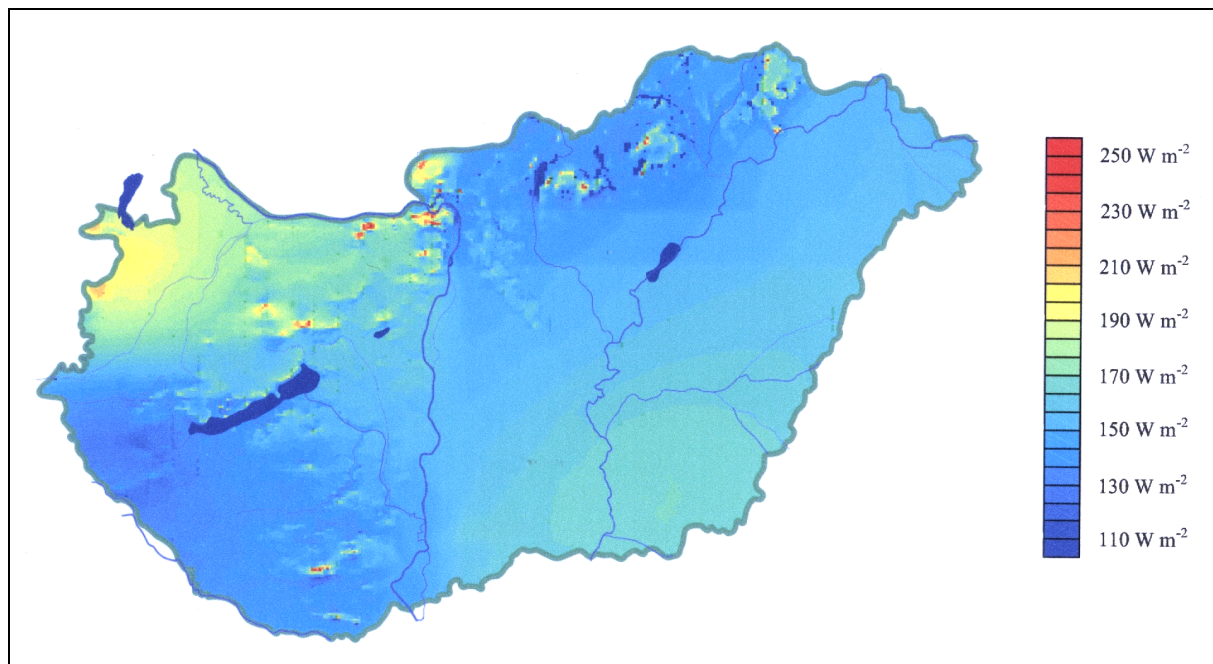


Figure 2. Wind power in the height of 80 metre. Source: Radics, K. 2004.

There are several calculations for the theoretically exploitable wind power of the country. One of the earliest ones demonstrates that the theoretical wind energy capacity of the whole country is 1,8 GW (Vajda, Gy. 1999). The basis of this counting is the fact, that the kinetic energy is 15 TW in the height of 100-200 m segment of atmosphere. Approximately 20% of this belongs to the continents, namely 3 TW. As the territory of Hungary is about 0,6% of the whole mainland the final theoretical capacity is 1800 MW.

A more sophisticated study already calculates with the bigger capacity of the new generation of wind turbines. (Hunyár, M. et al. 2006). In this version the final result is 10,25 GW.

4. Technical wind energy potentials in Hungary

To determine the more realistic technical potential, it is essential to estimate how large a fraction of that land could be made available for the exploitation of wind power. In the 2001 IPCC report, it is assumed that a use of 4% – 10% of that land area would be a reasonable value. This potential is influenced by legal regulations in the first place, as there are strict limitations due to the protected natural areas or the regulations of public health (for instance the question of noise pollution). In the second place there are technical limitations as well, for example the distance of the nearest suitable transmission line. This can likely be the starting-point of an expected wind energy project, still this is just a technical problem, which can be solved with a development investment and not as a strict limitation as the law.

Besides the land area, the capacity factor is another important question. It describes the efficiency of wind turbines and depends both on the technology and the wind climate. Its value generally changes between 20-48% in different circumstances. In Hungary the official publications calculate with 24% (MEH 2006) that is an optimistic value in our occasion.

It is important to point out that these capacity estimations do not take into account the practicality of reaching the windy sites, of transmission, of competing land uses, of transporting power over large distances, or of switching to wind power.

In our research we set out two sample areas (two counties: Győr-Moson-Sopron and Komárom-Esztergom) to determine the possibilities of wind energy applications. As a such project's most important assumption is the meeting of the legal requirements, first we made a screening with several parameters. In our GIS application we took

- a) the protected natural areas,
 - b) the protected landscapes;
 - c) the Environmentally Sensitive Areas (ESA);
 - d) the forests,
 - e) the hydrographical elements,
 - f) the roads, railways and airports,
 - g) the transmission lines (generally it is a primary condition of these kind of projects but in this context it is a vulnerable element of the infrastructure)
- into consideration as limitation factors.

In Győr-Moson-Sopron County the above mentioned limitations restrain the potential areas to 538 km², which is 13% of its whole territory (Munkácsy, B. 2004) . In Komárom-Esztergom County this rate is 10,7% (Munkácsy, B. et al. 2007), which means that its potential area is 241,4 km² (figure 3). These values are very close to the upper bound of 4-10% of the earlier mentioned IPCC-research. The difference in great part may be due to the fact, that in Hungary the ratio of arable land is almost 51%, which is far more than the average. It is important to know, that these areas present favourable conditions for wind turbine projects.

To obtain the technical potential the next step is to quantify the power capacity/km². According to the special literature this value varies in an extremely wide range:

Rogers, J.T. 2004:	3-5 MW/km ²
Beurskens, J. 2000:	6 MW/km ²
Henderson, A. R. et al. 2002:	3,7 MW/km ²
Power, S. et al. 2007:	8,5 MW/km ²
Ball, I. 2002:	10-20 MW/km ²

In Hungarian circumstances a down-to-earth value can be the 6-7 MW/km². To calculate with these numbers the technical wind energy potential is around 3500 MW in Győr-Moson-Sopron County and around 1500 MW in Komárom-Esztergom County.

If we take the whole territory of Hungary (93 030 km²) into account and we calculate according to the previous method (10% of the whole territory and 6-7 MW capacity per km²), the technical wind energy capacity of the country can be 55818-65121 MW.

It is an interesting fact, that the rather estimated theoretical potential is not as much as the calculated value of technical potential.

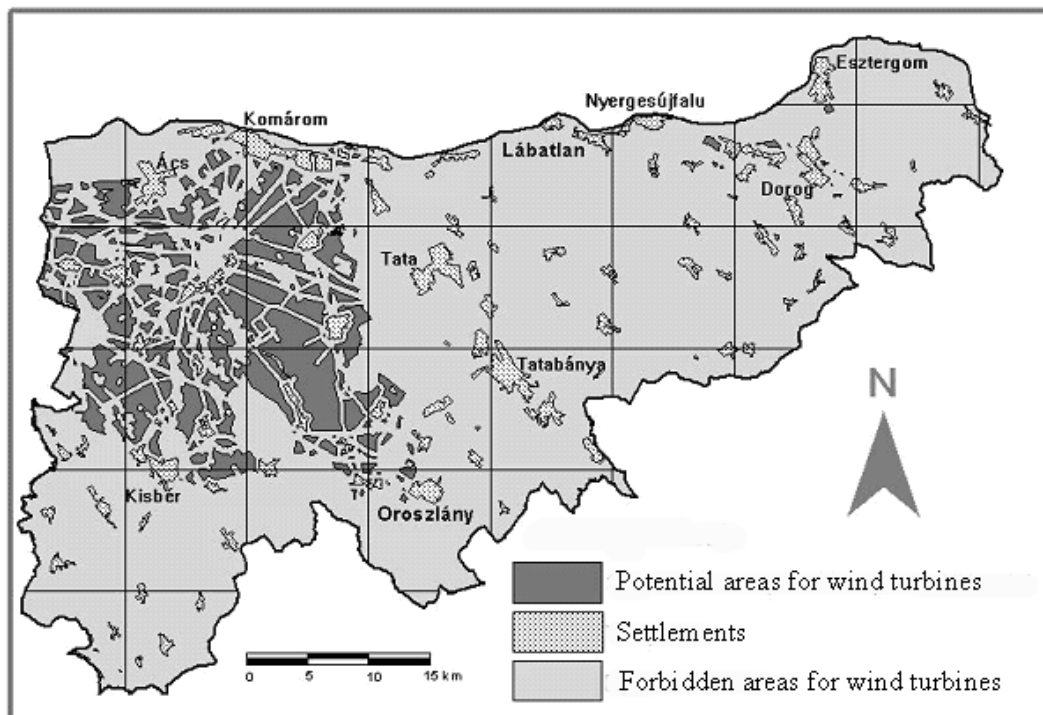


Figure 3. Potential areas for wind energy applications in Komárom-Esztergom County.
Source: Munkácsy, B. et al. 2007

5. Socio-economic wind energy potential of Hungary

To get the socio-economic potential we need to compare the Hungarian status with the international situation. The subject of this comparison will be Sachsen (a federal state of Germany), as the development of its wind energy sector is well documented and it is situated far from the seashore, similar to location of Hungary. Wind turbines appeared in Sachsen in 1990. After a ten-year period its wind energy capacity increased to 300 MW. If we compare it to the territory of the state, the capacity was 16,3 MW/km² in 2000.

In Hungary the technology appeared in 2000. A development in a same pace as happened in Sachsen would result in 1516 MW wind turbine capacity from 2000 until 2010. Can we reckon this value as the socio-economic wind energy potential of Hungary for 2010? If we compare the status of the two economies, the two different environmental policy and wind climates we can find out that 1516 MW is far more than the real possibility. The realizable capacity until 2010 is not more than 400 MW – if we take into consideration the Hungarian circumstances.

Table 1. Different wind energy potentials in Hungary and certain States in Germany

	Land area (km ²)	Wind turbine capacity (MW)	Capacity/land area (kW/km ²)
Sachsen – 2000. 12.	18400	300	16,3
Sachsen – 2007. 01.	18400	769	41,8
Hungary – 2007. 01.	93030	61	0,66
Hungary – in 2010 according to GKM (Bohoczky, F. 2003)	93030	30	0,3
Hungary – in 2010 according to GKM (Csillag, I. 2004)	93030	165	1,65
Hungary – 2010 (MEH 2006)	93030	330	3,3
Hungary – in 2010 (Munkácsy, B. 2004)	93030	400	4,3
Hungary – in 2010 (in comparison with the first 10-years development of Sachsen)	93030	1516	16,3
Hungary – in comparison with 20- years development of Sachsen	93030	3889	41,8

(Sources: compiled by Munkácsy, B. on the score of Ender, C. 2004b, Bohoczky, F. 2003 és Csillag, I. 2004, MEH 2006)

6. National plans for renewable energy usage – as implementation potentials

The importance of resolute climate policy is not a question anymore. All countries should create national programmes to promote energy efficiency applications and usage of renewable resources. In Hungary the development in this field is not fast enough. At present, only 4% of the Hungarian electricity demand is covered by renewable resources; it exceeds the 3,6% which was the assigned amount in Kyoto Protocol, but it is far from the 22,1%, which is the average European expectation for 2010. On the whole it is an urgent need to increase the capacity of our renewable resources and in this one of the most promising solutions is the wind energy.

Table 2. Power generation with renewable energy sources (GWh)

	2003	2010	2025
Geothermal	-	100	390
Solid biomass	109,0	1490	2840
Biogas	19,0	70	128
Hydro	171,0	223	300
Wind	3,6	340	1110
Photovoltaic	0,7	10	20
Σ	303,3	2233	4788

Source: Giber, J. et al.(2005)

The Ministry of Economy and Transportation has a study made on possibilities in this field (Table 2.) As we summarize the statements of experts, wind energy can be the second most important renewable energy source in Hungary (Giber, J. et al. 2005). According to the study the wind electricity can reach 340 GWh in 2010, and 1110 GWh in 2025. If we calculate an efficiency 24%, the proposed capacity can be 161,7 MW in 2010 and 523 MW in 2025. If we compare these figures to the calculated potentials, we can realize, that the sector's development seems to be underestimated. Nevertheless

these are far more than the value (30 MW wind turbine capacity) appeared on the website of the Ministry in 2003 (Bohoczky, F. 2003).

7. Conclusions

In Hungary the usage of renewable energy sources in power generation is still in its infancy. There are several hindering effects in this field:

- a) the land use planning and regional planning processes have weaknesses and deficiencies;
- b) the renewable sources do not have such strong lobby power as their rivals;
- c) their governmental support is insufficient and what is more, there are current damaging subsidy systems which hindering the penetration of green electricity;
- d) therefore the inducement for changing energy source is missing;
- e) we do not have enough knowledge about renewables and especially about potentials of renewables.

According to this paper, our possibilities are far more than the suggestions of the official/political side. And these findings are still valid for the other renewable energy sources too. We have huge potentials in solar and biomass as well as in geothermal energy. And our decision makers are still hesitating. Meanwhile the IPCC regularly publishes its reports which are more and more threatening. There is no any doubt that we should change our paradigm on energy management.

Hopefully this study contributes to clearing our vision about this topic and it can promote the spreading of these energy sources.

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